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Declaration

I, Michihiko Matsuba, President of Fukuyama Sangyo Honyaku Center, Ltd., of 16-3, 2-chome, Nogami-cho, Fukuyama, Japan, do solemnly and sincerely declare that I understand well both the Japanese and English languages and that the attached document in English is a full and faithful translation of the copy of Japanese Patent Application No. 2003-038347 filed on February 17, 2003.

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[TITLE OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] ELECTRONIC ENDOSCOPE SYSTEM

[WHAT IS CLAIMED IS;]

[CLAIM 1] An electronic endoscope system, comprising;

a pickup means provided at the distal end of an insertion portion;

an image-based processing means for converting signals picked up and outputted by the pickup means to visible image signals;

a main light source;

an auxiliary light source having a smaller light quantity than the main light source, which is turned on instead of the main light source; and

a light guiding member that guides illumination light emitted by the main light source or the auxiliary light source to the distal end of the insertion portion and emits the light from the distal end thereof;

wherein the image-based processing means sets a gain of signals outputted by the pickup means to a higher value when the auxiliary light source is turned on instead of the main light source than when the main light source is turned on, and processes the gain.

[Claim 2] An electronic endoscope system, comprising:

a pickup means provided at the distal end of an insertion portion;

an image-based processing means for converting signals picked up and outputted by the pickup means to visible image signals;

a main light source;

an auxiliary light source having a smaller light quantity than the main light source, which is turned on instead of the main light source; and

a light guiding member that guides illumination light emitted by the main light source or the auxiliary light source to the distal end of the insertion portion and emits the light from the distal end thereof;

wherein the pickup means actuates a normal electronic shutter that repeats pickup and output of picked-up signals at a predetermined cycle when the main light source is turned on; and

the pickup means actuates a long-period shutter that repeats pickup and output of picked-up signals at a longer cycle than the predetermined cycle when the auxiliary light source is turned on instead of the main light source.

[Claim 3] An electronic endoscope system, comprising;

a pickup means provided at the distal end of an insertion

portion;

an image-based processing means for converting signals picked up and outputted by the pickup means to visible image signals;

a main light source;

an auxiliary light source having a smaller light quantity than the main light source, which is turned on instead of the main light source; and

a light guiding member that guides illumination light emitted by the main light source or the auxiliary light source to the distal end of the insertion portion and emits the light from the distal end thereof;

wherein, when the main light source is turned on, the pickup means actuates a normal electronic shutter that repeats pickup and output of picked-up signals at a predetermined cycle, and the image-based processing means amplifies the picked-up signals outputted by the pickup means at the first gain, and processes the same, and

when the auxiliary light source is turned on instead of the main light source, the pickup means actuates a long period shutter that repeats pickup and output of the picked-up signals at a longer cycle than the predetermined cycle, and the image-based processing means amplifies the picked-up signals outputted by the pickup means at the second gain, which is higher

than the first gain, and processes the same.

[Claim 4] The electronic endoscope system according to any one of Claims 1 through 3, further including an electronic scope having a pickup means at the distal end of the insertion portion and a processor portion to which the electronic scope is detachably attached,

wherein the processor portion is provided with the image-based processing means, the main light source and the auxiliary light source; and

the light guiding member is provided in the interior of the electronic scope and the processor portion, and is optically connected when the electronic scope is connected to the processor portion.

[Claim 5] The electronic endoscope system according to Claim 2 or 3, wherein the long-period shutter actuation is a movement for repeating pickup and output of picked-up signals at a cycle that is an integral multiple of the predetermined cycle.

[Claim 6] The electronic endoscope system according to Claim 5, wherein the image-based processing means includes a memory means for storing the picked-up signals by one or more fields or frames, and, when the pickup means actuates the long-period shutter, reads the stored image signals equivalent to one or more fields or frames at the predetermined cycle and converts

the same to image signals that are able to be displayed by a displaying means.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Field of the Art]

The present invention relates to an electronic endoscope system having a main light source and an auxiliary light source.

[0002]

[Prior Arts and Themes Thereof]

In a light source device of an electronic endoscope, a high luminance lamp such as a halogen lamp, a mercury lamp, a metal halide lamp, etc., is used as the main light source. Where the light source is turned off due to its service life or malfunction while an inspection or an operation is carried out by an electronic endoscope, it is necessary that the light source or the light source device is replaced. It is not recommended that the endoscope is left in a body cavity of a patient during the replacement work.

Therefore, a light source device is disclosed by, for example, Patent Document 1, Patent Document 2 and Patent Document 3, which internally incorporates an auxiliary light source separately in addition to the main light source using a prior art high luminance lamp, illuminates the interior of a body

cavity with the light source changed to the auxiliary light source if the main light source is turned off, and is capable of completely removing the insertion portion from the body cavity under illumination by the auxiliary light source.

[0003]

Since the auxiliary light source is for emergency, it is preferable that the auxiliary light source is as small as possible since the frequency of use is very low, and deteriorates less chronologically. For example, a high luminance light-emitting diode (high luminance LED) is preferable (Patent Document 3).

However, where a high luminance LED is used as the auxiliary light source, the light quantity thereof is not sufficient in comparison with the main light source. Therefore, in the case of an electronic scope, there are cases where images picked up under a shortage of the light quantity are excessively dark.

[0004]

[Patent Document 1]

Japanese Unexampled Patent Publication No. 2000-210245

[Patent Document 2]

Japanese Unexampled Patent Publication No. Hei-10-18826

[Patent Document 3]

Japanese Unexampled Patent Publication No. 2002-72106

[0005]

[Object of the Invention]

The present invention was developed in view of the problems in the prior arts, and it is therefore an object of the present invention to provide an electronic endoscope system capable of acquiring clear and bright images when its auxiliary light source is turned on.

[0006]

[Summary of the Invention]

A light source device according to the present invention is featured in that it includes: a pickup means provided at the distal end of an insertion portion; an image-based processing means for converting signals picked up and outputted by the pickup means to visible image signals; a main light source; an auxiliary light source having a smaller light quantity than the main light source, which is turned on instead of the main light source; and a light guiding member that guides illumination light emitted by the main light source or the auxiliary light source to the distal end of the insertion portion and emits the light from the distal end thereof; wherein the image-based processing means sets a gain of signals outputted by the pickup means to a higher value when the auxiliary light source is turned on instead of the main light source than when the main light

source is turned on, and processes the gain.

With this configuration, when being illuminated by an auxiliary light source that is darker than a main light source, it becomes possible to obtain bright image signals and to execute observation based on bright images.

[0007]

Another invention is featured in that the pickup means actuates a normal electronic shutter that repeats pickup and output of picked-up signals at a predetermined cycle when the main light source is turned on; and the pickup means actuates a long-period shutter that repeats pickup and output of picked-up signals at a longer cycle than the predetermined cycle when the auxiliary light source is turned on instead of the main light source.

Also, with this configuration, when being illuminated by an auxiliary light source that is darker than a main light source, it becomes possible to obtain bright image signals and to execute observation based on bright images.

[0008]

Still another invention is featured in that, when the main light source is turned on, the pickup means actuates a normal electronic shutter that repeats pickup and output of picked-up signals at a predetermined cycle, and the image-based processing

means amplifies the picked-up signals outputted by the pickup means at the first gain, and processes the same, and when the auxiliary light source is turned on instead of the main light source, the pickup means actuates a long period shutter that repeats pickup and output of the picked-up signals at a longer cycle than the predetermined cycle, and the image-based processing means amplifies the picked-up signals outputted by the pickup means at the second gain, which is higher than the first gain, and processes the same.

With this configuration, when being illuminated by an auxiliary light source that is darker than a main light source, it becomes further possible to obtain bright image signals and to execute observation based on bright images.

[0009]

The present invention is preferable to an electronic endoscope system that includes an electronic scope having a pickup means at the distal end of the insertion portion and a processor portion to which the electronic scope is detachably attached, wherein the processor portion is provided with the image-based processing means, the main light source and the auxiliary light source; and the light guiding member is provided in the interior of the electronic scope and the processor portion, and is optically connected when the electronic scope is connected

to the processor portion.

It is preferable in view of ease in configuration and control that the long-period shutter actuation is a movement by which pickup and output of picked-up signals are repeated at a cycle integral multiple of the predetermined cycle.

It is preferable that the image-based processing means includes a memory means for storing the picked-up signals by one or more fields or frames, and, when the pickup means actuates the long-period shutter, reads the stored image signals equivalent to one or more fields at the predetermined cycle and converts the same to image signals that are able to be displayed by a displaying means. According to the configuration, bright and clear images can be obtained while images displayed on a television monitor when being illuminated by the auxiliary light source are brought into a so-called coma-by-coma feeding state.

[0010]

[Preferred Embodiments of the Invention]

Hereinafter, a description is given of the present invention based on the drawings. FIG. 1 is a view showing the major configuration of an embodiment in which a light source device according to the present invention is applied to an electronic endoscope system.

[0011]

The electronic scope 10 includes a flexible insertion portion 11, an operation portion 12 secured at the proximal side of the insertion portion 11, a universal tube 13 one end of which is connected to the operation portion 12, and a connector portion 14 having an optical connector 14a and an electrical connector 14b, which are secured at the other end part of the universal joint 13. The distal end of the insertion portion 11 has an electronic camera (a video camera) 6 including a pickup lens and a pickup device (CCD) 16a, etc., internally incorporated therein. The electronic camera 16 is disposed so as to be able to pick up the exterior through an observation window (an objective window) secured at the distal end side of the insertion portion 11. Further, an emission end side 15b of a light guide (optical fiber bundle) 15 operating as a light guiding member for illumination and a forceps portion (not illustrated), etc., are disposed at the distal end side of the insertion portion 11. Operation buttons for controlling photographing of moving images and still images by an electronic camera, and a curving operation knob for operating a curving mechanism secured in the vicinity of the distal end portion of the insertion portion 11 are provided at the operation portion 12. Further, the electronic scope 10 is provided with a CCD drive circuit 18,

which drives a pickup device 16a of the electronic camera 16 and executes image pickup, in the connector portion 14.

[0012]

The processor portion 20 is internally provided, as an image signal processing system for processing analog signals picked up by the electronic camera 16, with the first and the second amplifiers OP1, OP2 for amplifying inputted signals at the first and the second gains, respectively, an A/D converter 41 for analog-digitally converting the amplified analog signals outputted from either one of the first or the second amplifiers OP1, OP2, a DSP 42 for executing predetermined signal processing for the digital signals converted by the A/D converter 41, a memory 43 for storing the digital image signals, which are converted by the DSP 42, by at least one or more fields or frames, and a D/A converter 44 for converting the digital image signals, which are read from the memory 43, to analog video signals. Furthermore, the processor portion 20 is provided with a signal change switch SW1 for selecting signals, which are inputted into the A/D converter 41, from either one of the first or the second amplifier OP1, OP2. These amplifiers OP1, OP2, A/D converter 41, DSP 42, memory 43, and D/A converter 44 compose the image-based processing means.

[0013]

The processor portion 20 is further provided with a microcomputer 45 for controlling the electronic camera 16 and respective members of the image signal processing system via the CCD drive circuit 18. Also, the microcomputer 45 is driven under control of the controller 31 that controls the entirety of the electronic endoscope system.

[0014]

The signal cable 17 is accommodated in the insertion portion 11, the operation portion 12 and the universal tube 13, one end of which is connected to the electronic camera 16, and the other end of which is connected to a pin of the electric connector 14b of the connector portion 14. One end of the image cable 22 is connected to a pin of the electric connector 21b of the connector portion 21, and the other end thereof is connected to respective input ports of the first and the second amplifiers OP1, OP2. The respective input ports of the electronic camera 16, the first and the second amplifiers OP1, OP2 are connected via the signal cable 17, electric connector 14b of the connector portion 14, electric connector 21b of the connector portion 21 and the image cable 22.

[0015]

A television monitor that is able to display images picked up by the electronic camera 16 as visible images is connected

to the D/A converter 44 via a video encoder (not illustrated), and one who operates the electronic endoscope 10 operates the endoscope 10 while observing the images of the television monitor. Further, a peripheral memory device such as a video deck that records images, image signal inputs of a personal computer in addition to the television monitor are able to be connected to the D/A converter 44.

[0016]

The proximal end portion of the light guide 15 is connected from the distal end side of the insertion portion 11 to the optical connector 14a in the connector portion 14. And, the optical connector 14a is simultaneously connected to the optical connector 21a in the connector 21 when the connector portion 14 is connected to the connector portion 21, wherein the incidence end side 15a of the light guide 15 is optically connected to the emission end side 25b of the light guide (optical fiber bundle). The incidence end side 25a at the proximal end portion of the light guide 25 is disposed at the incident position of illumination light emitted from the main light source 27. An aperture 26 is disposed in the optical path of the main light source between the main light source 27 and the incident end side 25a, and the light quantity incident into the incident end side 25a is adjusted by opening and closing of the aperture

26. The aperture 26 is controlled by the system controller 31 via an aperture drive circuit 38.

[0017]

Illumination light emitted from the main light source 27 and incident through the incident end side 25a is guided to the light guide 25, emission end side 25b, incident end side 15a and light guide 15, and is emitted from the emission end side 15b of the light guide 15 and the illumination window at the distal end side of the insertion portion 11 to the periphery, thereby illuminating the interior of a body cavity.

[0018]

Lighting of the main light source 27 is driven and controlled by the main light source power source 28. The main light source power source 28 controls lighting of the main light source 27 by means of electric current stabilized by a stabilization power source circuit 30 upon receiving power supply from the commercial power source 29.

[0019]

Normally, a high luminance lamp such as a halogen lamp, a mercury lamp, a metal halide lamp, etc., is used as the main light source 27, and the high luminance lamp is installed to a lamp socket having a reflection umbrella. The high luminance lamp is provided with a light condensing lens (not illustrated)

that converges a light flux emitted from the main light source 27 and efficiently causes the light flux to enter the incident end side 25a of the light guide 25. The main light source 27 and the light guide 25 are disposed so that the convergence position of the main light source 27 is aligned with the incident end side 25a.

[0020]

In the processor portion 20, an auxiliary light source 32 that is turned on instead of the main light source 27 when the main light source 27 is turned off due to its service life or specified malfunction, and supplies illumination light is provided. A high luminance light emitting diode (high luminance LED) is used as the auxiliary light source 32 in the present embodiment. Turning-off of the main light source 27 is detected by an optical sensor 39 and a turning-off detection circuit 40, and a turning-off detection signal is transmitted to the system controller 31, wherein turning-on of the auxiliary light source 32 is driven and controlled by the auxiliary light source drive circuit 33 when the auxiliary light source drive circuit 33 receives an auxiliary light source drive circuit 33 from the system controller 31. Further, the auxiliary light source drive circuit 33 is operated by a constant-voltage current supplied by the stabilization power source circuit 30.

[0021]

Further, the auxiliary light source drive circuit 33 moves the auxiliary light source 32 to the standby position outside the main light source optical path and the use position (auxiliary light source turning-on position) opposite to the incident end side 25a in the main light source optical path, and the drive circuit 33 turns on the auxiliary light source 32 at the use position. In addition, normally, the auxiliary light source 32 is held at the standby position outside the main light source optical path and is turned off.

[0022]

A further description is given of the mechanical configuration of the light source device with reference to FIG. 2 and FIG. 3. FIG. 2 and FIG. 3 are perspective views showing the major parts of the present embodiment, wherein FIG. 2 shows a normal state where the main light source 27 is turned on, and FIG. 3 is a turned-on state where the auxiliary light source 32 is moved to its use position and is turned on.

[0023]

The auxiliary light source 32 is fixed at one end of an L-shaped lever 51. The lever 51 has its corner portion 51a pivotally supported at a pressing plate 52 by means of an axis 51a, and an actuator 34 is coupled to the other end thereof. The actuator

34 is a rotary actuator, in which an axis 53a is implanted at an eccentric position of a rotating plate 53 fixed at a rotating axis (not illustrated), and the axis 53a is fitted in a slot 51b formed at one arm portion of the lever 51 along the arm portion.

[0024]

When the actuator 34 is in a current-free state by a control signal from the auxiliary light source drive circuit 33, the rotating plate 53 is held at a default position, and the lever 51 is held in its default state. The default state is a normal state, wherein the auxiliary light source 32 fixed at one end portion of the lever 51 is held at a standby position outside the main light source optical path.

[0025]

As a current is supplied to the actuator 34 by a control signal from the auxiliary light source drive circuit 33, the rotating plate 53 is turned only by a predetermined angle in the clockwise direction, and the lever 51 turns in the counterclockwise direction around the axis 51a in line with the turning of the rotating plate 53, and the auxiliary light source 32 is moved to its use position, that is, to the use position opposite to the incident end side 25a. And, the auxiliary light source 32 is held at the use position while

a current is supplied to the actuator 34. When the auxiliary light source drive circuit 33 receives a turning-on signal of the auxiliary light source from the system controller 31, the auxiliary light source drive circuit 33 supplies a current to the auxiliary light source 32 to cause the auxiliary light source 32 to emit light, and at the same time, moves the auxiliary light source 32 to the light emitting position of the auxiliary light source.

[0026]

Also, although not illustrated in detail, the main light source 27 is provided with a cooling fan for cooling the main light source 32 since the main light source 32 is subjected to high temperature during lighting. In addition, the auxiliary light source 32 may be provided with an auxiliary light source cooling means 32 as necessary where only air stream cooling by the cooling fan is insufficient.

[0027]

The light quantity of the auxiliary light source 32 is less in comparison with that of the main light source 27 because the auxiliary light source according to the present embodiment is an LED. Therefore, even if the LED is driven and illuminates the interior of a body cavity at a constant current value around the absolute maximum rating of forward current of the LED, the

brightness of image signals obtained by image processing is lower than that based on illumination of the main light source 27, wherein images displayed on a monitor television set are dark.

[0028]

Therefore, in Embodiment 1 according to the present invention, it is devised that, when being in the turning-on mode of the auxiliary light source where the auxiliary light source is turned on, the gain is doubled by changing the first amplifier OP1 to the second amplifier OP2, and a brighter image can be obtained. FIG. 4 shows an image signal in the case where the second gain of the second amplifier OP2 is made double of the first gain of the first amplifier with the first gain of the first amplifier OP1 made into a reference.

In addition, in the turning-on mode of the auxiliary light source, the gain is not limited to two times, and it may be three times or four times, or may be less than two times.

[0029]

In Embodiment 2 according to the present invention, the electronic shutter is changed to a long-period shutter instead of increasing the gain by changing the first amplifier OP1 to the second amplifier OP2. FIG. 5 shows a timing chart thereof. The CCD pickup element 16a of the electronic camera 16 repeats

exposure and output of picked-up signals at a predetermined cycle of 1/60 second per field, and normally operates at an electronic shutter speed that is shorter than 1/60 seconds when an electronic shutter operates. Also, when the long-period electronic shutter operates, exposure is carried out over two fields, and pickup signals are outputted once every field. Therefore, it is possible to lengthen the charge accumulation period of a pickup signal per field, wherein a brighter image can be obtained.

[0030]

FIG. 5(A) shows a timing chart in the case of 1/60 seconds, which is the slowest in normal electronic shutter operation, and FIG. 5(B) shows a case where the long-period electronic shutter operates. The long period mode illustrated corresponds to 1/30 second over two fields. In this case, although images equivalent to only 30 fields are obtained per second, images equivalent to one field of two fields stored in the memory 43 are read and outputted at 1/60 second cycle in the present embodiment. Therefore, smooth dynamic images free from flickering and jerky movement can be displayed on a monitor television set.

[0031]

Also, the electronic shutter speed in the long-period shutter

operation is not limited to the present embodiment, and may be three or four fields or more, that is, may be a long period over fields of an integral multiple of one field. In addition, it is preferable that output of pickup signals is synchronized with a synchronization signal (vertical synchronization signal) outputted at a predetermined cycle because the control is facilitated. However, the pickup time (exposure or charge accumulation time) may not be the time of the integral multiple of one field.

[0032]

Embodiment 3 according to the present invention employs Embodiments 1 and 2 altogether. That is, in the case of a turned-on mode of the auxiliary light source, the amplifier OP1 is changed to the amplifier OP2 to make the gain double, and the electronic shutter is changed to a long-period mode.

[0033]

A description is given of processing in Embodiment 3 with reference to a flowchart shown in the drawing. The system controller 31 commences the flowchart of turning-on processing in a state where the power source switch SWP is turned on and the commercial power source 29 is supplied. In the drawings and the specification, a step is symbolized to be [S] for description.

[0034]

As the processing is commenced, it is checked (in S11) whether the power switch SWP is turned on. When the power source switch SWP is not turned on, the main light source 27 and the auxiliary light source 32 are turned off, and the processing is finished (S11: N, End).

[0035]

When the power source switch SWP is turned on, the main light source 27 is turned on, and normal gain and normal electronic shutter are operated under the condition that the main light source current is not almost zero. That is, the gain change switch SW1 is connected to the amplifier OP1 to cause the microcomputer 45 to actuate the normal electronic shutter (S11: Y, S15, S17: N, S19, S11). The above processing is repeated with the power source switch SWP turned on while the main light source current flows.

[0036]

If the main light source 27 is turned off or the safety device operates due to a specified cause, and the main light source current decreases (S17: Y), the main light source 27 is turned off (S21), the actuator 34 is driven to cause the auxiliary light source 32 to move to the use position (S23), wherein the auxiliary light source 32 is turned on (S25). Further, the gain

is increased, the electronic shutter is changed to a long-period mode (S27), and the microcomputer waits for turning-off of the power source switch SWP (S29). That is, the gain change switch SW1 is changed to the second amplifier OP2 and is connected thereto, and the microcomputer 45 causes the electronic shutter to operate in the long-period mode and waits for turning-off of the power source switch SWP. If the power source switch SWP is turned off, the auxiliary light source 32 is turned off, and the actuator 34 is driven to cause the auxiliary light source 32 to retreat to its standby position. Then, the lighting process is finished (S29: Y, S31 and S33 are finished).

Since, when the auxiliary light source 32 is turned on, an operator is able to observe bright and clear images, which are picked up by the electronic shutter 16 in the turning-on mode of the auxiliary light source, on a television monitor display, the operator operates the operation portion 12 while observing the images on the television monitor display, pulls out the insertion portion 11 from a body cavity, turns off the power source switch SWP, and replaces the main light source 27 for a new one.

[0037]

As described above, according to the embodiments of the present invention, where the main light source 27 is turned

off due to a specified reason, the auxiliary light source 32 is moved to its use position, and not only illuminates the interior of a body cavity instead of the main light source 27 but also increases the gain of the picked-up image signals, changes the electronic shutter speed of the electronic camera 16 to the long-period mode, or carries out both at the same time, and visualizes bright and clear images on a television monitor display by compensating a shortage in light quantity of the auxiliary light source 32. In addition, it is possible to obtain bright and clear images since, by concurrently employing Embodiments 1 and 2, there is no case where noises of the image signals become outstanding with the gain of the image signals raised excessively, and there is no case where color deviation and flickering become remarkable by extreme lengthening of the electronic shutter.

[0038]

[Effects of the Invention]

As has been made clear based on the above description, since, in the present invention, the processing is executed in a state where the gain for amplifying signals outputted by a pickup means when the auxiliary light source is turned on is set to be higher than the level when the main light source is turned on, it becomes possible to obtain bright and clear images with

an auxiliary light source which is darker than the main light source.

Also, since, in another invention, a long-period shutter is operated which repeats pickup and output of picked-up signals at a longer cycle when the auxiliary light source is turned on than a predetermined period when the main light source is turned on, the light quantity is increased, wherein bright and clear images can be obtained.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1] is a view showing the main configuration of Embodiment 1 of an electronic endoscope system to which the present invention is applied;

[FIG. 2] is a perspective view showing a normal state of a movement mechanism of an auxiliary light source according to Embodiment 1;

[FIG. 3] is a perspective view showing the movement mechanism of an auxiliary light source according to Embodiment 1 in a state where the auxiliary light source is turned on;

[FIG. 4] is a view showing one example of a timing chart regarding an increase in gain when the auxiliary light source is turned on, according to Embodiment 1;

[FIG. 5] is a view showing one example of a timing chart regarding a long-period mode of an electronic shutter when the

auxiliary light source is turned on, according to Embodiment 1; and

[FIG. 6] is a flowchart showing turning-on processing according to Embodiment 3 of the electronic endoscope system.

[Description of Symbols]

10 Electronic scope

11 Insertion portion

12 Operation portion

13 Universal tube

14 Connector portion

14a Light guide connector

14b Electric connector

15 Light guide (Optical fiber bundle)

15a Incident end side

15b Emission end side

16 Electronic camera

16a CCD pickup element

20 Processor portion

21 Connector portion

21a Light guide connector

21b Electric connector

25 Light guide (Optical fiber bundle)

25a Incident end side

25b Emission end side

26 Aperture

27 Main light source

28 Main light source power source

30 Stabilized power circuit

32 Auxiliary light source

33 Auxiliary light source drive circuit

34 Actuator

OP1 First amplifier

OP2 Second amplifier

SWP Power source switch

SW1 Signal change switch

[TITLE OF DOCUMENT] Abstract

[ABSTRACT]

[OBJECT] To provide an electronic endoscope system capable of obtaining bright and clear images when an auxiliary light source is turned on.

[COMPOSITION] The electronic endoscope system includes: an image-based processing means that has an electronic camera 16 at the distal end of the insertion portion 11 and converts signals picked up and outputted by the electronic camera 16 to visible image signals; and light guides 25,15 that have a main light source 27 and an auxiliary light source 32 being turned on instead of the main light source 27, the light quantity of which is smaller than the main light source 27, guide illumination light emitted by the main light source 27 or the auxiliary light source 32 to the distal end of the insertion portion, and emits the illumination light through the distal end thereof, wherein when the main light source 27 is turned on, the electronic camera 16 actuates a normal electronic shutter that repeats pickup and output of picked-up signals at a predetermined cycle, and the image-based processing means executes processing after amplifying the picked-up signals outputted by the pickup means at the first gain, and when the auxiliary light source 32 is turned on instead of the main light source 27, the electronic

camera 16 actuates a long-period shutter that repeats pickup and output of picked-up signals at a longer cycle than the predetermined cycle, and the image-based processing means executes processing after amplifying the picked-up signals outputted by the pickup means at the second gain higher than the first gain.

[SELECTIVE DRAWING] FIG. 6

[FIG. 1]

18 CCD drive

34 Actuator

45 Microcomputer

43 Memory

To monitor display

31 System controller

30 Stabilized power circuit

SWP Power source switch

29 Commercial power

33 Auxiliary drive circuit

38 Aperture control circuit

40 Turning-off detection circuit

28 Main light source power source

FIG. 2

FIG. 3

FIG. 4

Image signal

Where the gain is doubled

FIG. 5

One field

Vertical synchronization signal

Light irradiation period

Image signals from CCD

One field

Vertical synchronization signal

Light irradiation period

Image signals from CCD

Image signals read from memory

FIG. 6

Turn on

S11 Power source switch SWP turned on?

S15 Main light source turned on or a turned-on state maintained.

S17 Main light source current =0?

S19 Normal gain and normal electronic shutter actuated.

S13 Main light source and auxiliary light source turned off.

END

S21 Main light source turned off.

S23 Auxiliary light source moved.

S25 Auxiliary light source turned on.

S27 Gain increased and electronic shutter lengthened.

S29 Power source switch SWP turned ON?

S31 Auxiliary light source turned off.

S33 Auxiliary light source retreated.

END

Fig.1

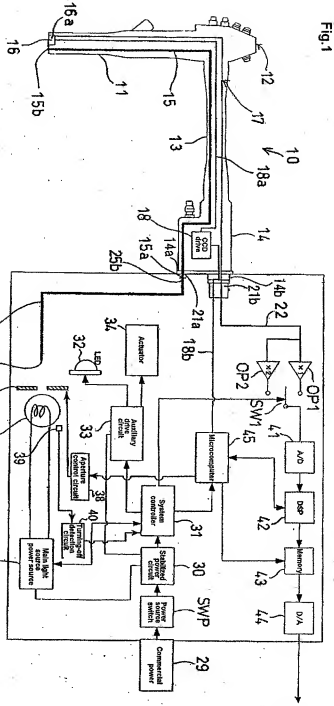

10
11
12
13
14
14a
14b
15
15a
15b
16
16a
17
18
18a
18b
21a
21b
22
25
25a
25b
26
27
28
29
30
31
32
33
34
39
40
41
42
43
44
45
OP1
OP2
SW1
SWP
A/D
DSP
Memory
D/A
Macrocomputer
System controller
Shutter/AF control circuit
Power switch
Commercial power
Auxiliary drive circuit
Actuator
LED
Aperture control circuit
Zooming-out control circuit
Main light source power source
To monitor display

Fig.2

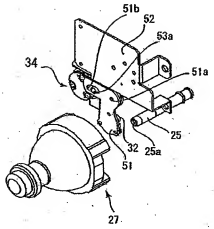


Fig.3

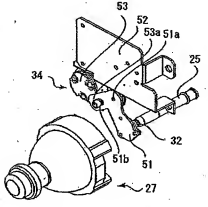


Fig.4

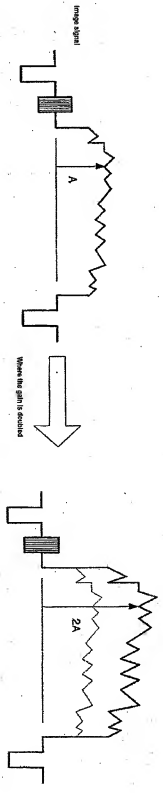


Image signal
A
When the gain is doubled
2A

Fig.5

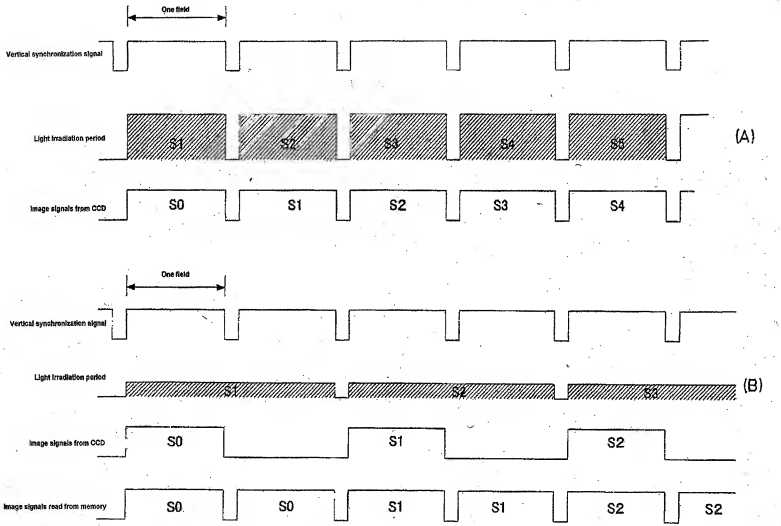
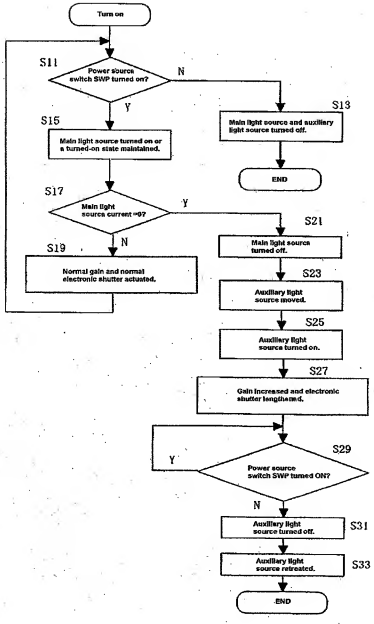


Fig.6


Turn on
S11
Power source switch SWP turned on?
N
Y
S13
Main light source and auxiliary light source turned off.
END
S15
Main light source turned on or is turned-on state maintained.
S17
Main light source current =0?
Y
N
S19
Normal gain and normal electronic shutter actuated.
S21
Main light source turned off.
S23
Auxiliary light source moved.
S25
Auxiliary light source turned on.
S27
Gain increased and electronic shutter lengthened.
S29
Power source switch SWP turned ON?
Y
N
S31
Auxiliary light source turned off.
S33
Auxiliary light source retreated.
END